

DG emissions and efficiency

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Distributed generation's (DG'S) environmental bearing-in general and on air quality in particular-is site-specific and rarely unambiguous. While DG systems can produce fewer emissions and are cleaner than older central-station power generation, state environmental regulators are starting to focus on DG emissions.

There also may be local regulators, especially in those cities classified as nonattainment areas by the Environmental Protection Agency (EPA) that could become more involved as more DG is used.

But contrasting the environmental advantages of various DG systems with different types of central-station powerplants raises a host of comparative challenges.

Comparing Emissions

At least 90 percent of back-up onsite generation units are internal combustion engines that run on diesel fuel. According to a report published late last year by the Renewable Energy Policy Project (REPP), there were 667,626 diesel generators in the United States in 1998, with a total generating capacity of 108,797 megawatts (Mw). At an annual growth rate of 1.7 percent, according to the report, this number could reach 127,500 Mw in 2010.

But diesel generators have the highest emissions of any fossil-fueled powerplant by far, according to REPP'S Virinder Singh.

These generators released nearly 300,000 tons of nitrogen oxides (according to 1996 statistics); overall Nox emissions from fossil-fueled powerplants in 1999, according to EPA, were 5.715 million tons. A report by James Lents and Juliann Allison of the University of California, Riverside, also confirms that diesel DG systems consistently had the highest emission factors in terms of pounds per kilowatt-hour (kwh) generated. Lents and Allison compared emission factors for various DG technologies with those of combined-cycle gas turbine systems (CCGT). The CCGT systems had the lowest or second-lowest emission factor for many of the emissions listed. (Only the proton exchange membrane-or direct--fuel cell, which showed 0.00000 values for some emissions, had lower values).

On the other hand, comparing emissions between a natural gas-based DG system and a coal-based plant reveals that the former releases fewer. But gas--based DG functions primarily at peak, while a coal-based plant is used for baseload operations. Currently DG capacity comes at a high cost, while coal generators have very low operating costs: Without major improvements to DG technology, baseload coal powerplants will continue to be more economical and efficient.

A more meaningful and realistic comparison is to be made between all DG systems and peaking powerplants, which are likely to be single-cycle turbines using natural gas or oil. The differences in emissions between gas turbines and gas DG technologies are small. And most emissions from utility peaking plants are near the values for those of microturbines, while they are higher than those of fuel cells.

Other DG systems, such as microturbines, can operate on a variety of fossil fuels from natural gas to propane to diesel fuel. The environmental impact of these systems is directly dependent on system efficiency and type of fuel used.

DG Efficiency

Newer central-station powerplants are usually more efficient than fossil-fueled DG, even considering a reduction in transportation losses. CCGTs typically convert 55-57 percent of the fuel into electricity, while newer technologies are projected to achieve a 60- percent efficiency. Lents and Allison show that fossil fuel-based DG systems convert only 27-44 percent of their fuel into electricity: Of the various technologies, only diesel internal combustion engines are higher than 40 percent. In a draft report released in November 2001, the Regulatory Assistance Project reveals similar efficiency-- only solid oxide fuel cells pierce the 40-percent efficiency mark, while microturbines come in last.

While CCGTs have the highest fuel efficiencies, there are losses in transporting the energy to load. Transmission and distribution losses on a national basis are approximately 7.5 percent, and they remain relatively stable over time. Deducting these losses from the efficiency percentage of cars still leaves cars more efficient than the most efficient types of DG, diesel engines, and fuel cells.

Recycling Heat Into Energy

Reusing industrial heat for power generation improves the environmental performance of all fossil-fueled DG, but by how much depends on the situation. Large-scale fossil-fueled combined heat and power (CHP) systems have existed for more than 100 years, especially in industrial facilities with large thermal or process steam needs. When combined with the latest DG technologies, CHP will have an impressive air quality and efficiency improvement on the stand-alone system. Whether this is enough to surpass the efficiency of baseload generation depends on many factors, including whether the customer's need for heat and electricity occurs at the same time, whether the efficiency and emissions of the generation are supplanted, and when the facility operates.

A 750-kilowatt diesel generator was one of many supplying emergency power in the wake of the World Trade Center disaster.

CHP emission levels depend on the current and projected fuel mix of the local or regional grid-based power supply. In some cases,

levels will be low, and in other cases, such as the Pacific Northwest, with its preponderance of hydroelectric generation, CHP system emissions will be higher.

The efficiency of these systems also depends on several factors. For example, if the heat comes from a fossil-fueled boiler, there might not be enough pressure in the waste heat to spin a turbine, thus requiring additional fuels. Moreover, the waste heat may be better used to heat water or for space heating than for electricity generation.

In the final analysis, when air pollution issues are considered, only the lowest-- emitting DG system with significant waste heat recovery is even marginally competitive with combined cycle power production. In the United States, nuclear energy, hydroelectric, wind, and solar central station systems provide over 30 percent of the electricity needed--emissions-free. Adding DG into the generation portfolio will improve air quality most significantly only if it substitutes for new or existing fossil-fueled generators.

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